IMPROVED HYDRATION OF GUAR GUM POWDER

Manjit S. Chowdhary
3 Cambridge Way
Princeton Junction, New Jersey 08550
Citizenship: U.S.

Walter M. White
13411 Kimberley Lane
Houston, Texas 77079
Citizenship: U.S.

TECHNICAL FIELD OF THE INVENTION

This invention relates generally to a process of improving the hydration characteristics of guar gum powder, and more specifically to a method including the step of extruding guar gum splits prior to grinding same so as to enable such improved hydration characteristics.

BACKGROUND OF THE INVENTION

Guar gum comes from a plant that is grown primarily in India and Pakistan, although other climates are also friendly to its cultivation. Guar is a legume-type plant that produces a pod, much like a green bean. In the pod there are seeds that, upon heating, split open exposing the endosperm and meal. The resulting product is then differentially ground to purify the endosperm. Such purified endosperm is referred to a "split."

The exposed endosperm contains a polymer of great use for thickening industrial and commercial fluids. The polymer is a polysaccharide material known as polygalactomannan. This material develops a high viscosity via hydration of the fluid to be thickened, similar to the action of starch. The guar endosperm polymer is much more efficient than starch in developing viscosity, however.

Guar gum has numerous applications in the oil industry as an additive to drilling and fracturing fluids. Other industrial and commercial applications abound. For example, it is used in the explosives industry to thicken gelled explosives. It is used as a food additive as a thickener. It is used in paper manufacturing to increase the water-absorption and wet strength characteristics of paper. It is used in textiles in carpeting as part of the colorizing or shading process. Another use is in animal litter to enhance clumping characteristics. Further uses include synthetic fuel briquette manufacture, and in firefighting to deliver thickened water to smother fires.

Guar gum powder is known in the art to be manufactured primarily by flaking the hydrated splits, then grinding the flakes, and then drying the resulting powder. Just like any powder, guar gum's hydration characteristics are related to the particle size of the powder. The smaller the particles, generally the better the hydration characteristics (and principally the faster the hydration) because the surface area of the powder has increased.

Fast hydration is a goal of many of the industrial and commercial applications set forth above. In particular, in oilfield stimulation, the technique is to hydrate to full hydration as quickly as possible so as to waste as little product as possible. Rapid hydration also enhances fluid pumping performance.

In animal litter applications, rapid hydration allows the litter to clump faster and thereby makes for a better, more efficient product. For example, cat fluids do not drop to the bottom of the pan, they stay at the top.

In synthetic fuel applications, a better pellet or briquette results if the product is fully hydrated as it is dried. In explosives, the product is typically ruined if it takes on water when, for example, it is buried in the ground. If the product contains an agent that hydrates quickly, it seals the water from the explosive.

Reducing particle size to improve hydration is not always advantageous, however. Reducing particle size requires additional manufacturing costs in grinding and screening the product. It also creates additional fines which are hard to manage, package, and cause wasted product.

There is therefore a need in the industry to develop a guar gum powder whose hydration rate is increased while maintaining optimum particle size.

Hydration rate is not the only characteristic of guar gum powder that is of interest to the industrial and commercial applications described above. Hydration acceleration rate is also important. If hydration cannot reach, say, 50% hydration fast enough, the guar powder may be unsuitable for the application, even though the overall hydration rate may be acceptable.

There is therefore also a need in the industry to develop a guar gum powder having both faster hydration and faster hydration acceleration rates.

Responsiveness of the hydration rate to lower temperatures is also important. Typically, the lower the ambient temperature, the slower the hydration acceleration rate, even when the absolute time for 100% full hydration is acceptable. For example, in oil fracturing fluids applications in cold places such as the Rockies, Alaska, Canada, Russia and Scandinavia, the use of guar gum powder may not always be optimal when the hydration acceleration rate is slowed by the cold.

There is therefore also a need in the industry to develop a guar gum powder whose hydration acceleration rate is not as adversely affected by low ambient temperatures.

SUMMARY OF THE INVENTION

These and other objects, features and technical advantages are achieved by a method in which the manufacture of guar gum powder includes the step of extruding the hydrated splits prior to drying. The extruding step may be included before or after the step of flaking the splits.

The inclusion of the step of extruding the hydrated splits in the manufacturing process has been found to create a guar gum powder product which has advantageous properties over the prior art. These advantageous properties include (1) increasing the hydration rate and hydration acceleration rate of the guar gum powder without any corresponding change in particle size, and (2) providing a hydration acceleration rate that is less affected by cold temperatures.

Extrusion is known to be a part of the manufacturing process of products from other crops such as wheat or corn. Where extrusion is used in such processes, however, its purpose is known to be for objectives totally unrelated to improving hydration characteristics of the product. Generally its purpose is to shape the product into a desired physical profile.

It is therefore a technical advantage of the present invention to provide a process of making guar gum powder that hydrates faster and whose hydration accelerates faster, than prior art powders of corresponding particle size. The potential benefits of such a product to industrial and commercial applications are described in detail in the "background" section of this disclosure.

A further technical advantage of the present invention is that the inventive process provides a guar gum powder product whose hydration acceleration rate is less affected by cold temperatures. The potential benefits of such a product in cold environments are also described in detail in the "background" section.

A yet further technical advantage of the present invention is that the resulting guar gum powder product has numerous applications as a high-performance hydrating or thickening agent when mixed, integrated or suspended with host products. These products include, in addition to the ones discussed in the "background" section of this disclosure:

shampoo, body wash, lotions and other personal care products;
household cleaner;
catalytic converter catalyst;
electroplating solutions;
diapers and sanitary towels;
super-adsorbents in food packaging;
sticking plasters for skin abrasions ("band-aids");
water-adsorbing bandages;
foliar spray for plant leaves;
suspension for spraying plant seeds or nutrients; and
flotation aid or flocculent in particulate separation or water treatment processes.

The foregoing has outlined rather broadly the features and technical advantages of the present invention in order that the detailed description of the invention that follows may be better understood. Additional features and advantages of the invention will be described hereinafter which form the subject of the claims of the invention. It should be appreciated by those skilled in the art that the conception and the specific embodiment disclosed may be readily utilized as a basis for modifying or designing other structures for carrying out the same purposes of the present invention. It should also be realized by those skilled in the art that such equivalent constructions do not depart from the spirit and scope of the invention as set forth in the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

For a more complete understanding of the present invention, and the advantages thereof, reference is now made to the following descriptions taken in conjunction with the accompanying drawings, in which:

FIGURES 1 and 2 illustrate guar gum powder manufacturing processes known in the art;

FIGURES 3 and 4 illustrate alternative exemplary guar gum powder manufacturing processes according to the present invention;

FIGURE 5 illustrates the hydration performance at 70 degrees F of guar gum powder made according to a known process such as is illustrated in FIGURE 1;

FIGURE 6 illustrates the hydration performance at 40 degrees F of guar gum powder made according to a known process such as is illustrated in FIGURE 1;

FIGURE 7 illustrates the hydration performance at 70 degrees F of guar gum powder made according to the present invention; and

FIGURE 8 illustrates the hydration performance at 40 degrees F of guar gum powder made according to the present invention.

DETAILED DESCRIPTION OF THE INVENTION

FIGURES 1 and 2 illustrate processes known in the art to manufacture guar gum powder. These processes typically include hydrating guar gum splits as an initial step (101, 201). Popular techniques hydrate the splits to about a 20% - 80% moisture content. The hydrated splits may then be flaked using milling techniques or other flaking operations known in the art (102). Alternatively, the prior art is known to simply omit the flaking process, as seen on FIGURE 2. The splits then proceed to a grinding operation (103, 202) and a drying operation (104, 203) to yield a guar gum powder. This powder is then screened (105, 204), and then packaged for distribution (106, 205).

A manufactured powder particle size is generally selected by artisans in this field to optimize the hydration characteristics of the powder. Finer powder will generally produce a product that hydrates faster. However, finer powder also costs more to produce and is harder to handle. Also, finer powder is more susceptible to loss through waste.

FIGURES 3 and 4 illustrate alternative embodiments of the process of present invention. It will be seen that, by comparison to FIGURES 1 and 2, the inventive process in FIGURES 3 and 4 includes an extrusion step (302, 402). The extrusion step is advantageously carried out after hydration of the splits (301, 401) and before grinding (304, 404). According to the invention, however, the extrusion step (302, 402) may be performed either before or after flaking (303, 403).

Extrusion as shown in FIGURES 3 and 4 may be accomplished by using a single screw extruder or by other means known in the art.

Adding the extruding step according to the present invention has been found to improve the hydration characteristics of guar gum powder without affecting particle size. These improved characteristics include (1) increasing both the hydration rate and the hydration acceleration rate, and (2) providing a hydration acceleration rate that is less affected by cold temperatures.

The improved hydration characteristics of a guar gum powder made according to the inventive process are disclosed herein by example.

EXAMPLE 1

FIGURES 5 and 6 illustrate the hydration performance of guar gum powder made according to a known process as illustrated in FIGURE 1, whereas FIGURES 7 and 8

illustrate the corresponding hydration performance of guar gum powder made according to the inventive process as shown on FIGURE 4. It will be understood, however, that similar hydration performance to FIGURES 7 and 8 has been achieved according to the process of FIGURE 3, in which extrusion step 302 precedes flaking step 303 instead of following it.

Specifically, the samples whose hydration performance is shown on FIGURES 5, 6, 7 and 8 were made as follows. Guar gum splits from the same batch were hydrated to about a 20 - 80% moisture content at about 80 - 200 degrees F. The splits were then converted to flakes using a Farrell-Ross flaker. About half of the flaked splits were then extruded through a Bonnot Corporation extrusion machine having a 2" - 8" barrel diameter. The other half of the flaked splits were not extruded. All splits were then ground to a powder, dried to about a 1 - 10% moisture content, and then screened so that the entire powder sample passed through a 100 mesh sieve.

The comparative rates of hydration of the samples were then measured and plotted as set forth on FIGURES 5, 6, 7 and 8. On FIGURES 5 and 7, the comparative hydration performance of the samples at 70 degrees F is shown. On FIGURES 6 and 8, the comparative hydration performance of the samples at 40 degrees F is shown.

FIGURE 7, when compared to FIGURE 5, shows that the hydration rate at 70 degrees F is appreciably faster for the guar gum powder made according to the inventive process with the extrusion on step. For example, the sample in FIGURE 7 is over 90% hydrated after 5 minutes, whereas the sample in FIGURE 5 does not achieve 90% hydration until about 20 minutes. Further, it will be seen that the hydration acceleration rate of the sample in FIGURE 7 is appreciably faster than in the sample of FIGURE 5.

Moreover, FIGURE 8, when compared to FIGURE 6, shows that the hydration acceleration rate of the sample made according to the inventive process is less affected by lower temperatures. For example, the inventive sample in FIGURE 8 is at least 50% hydrated after about 90 seconds at 40 degrees F, and about 90% hydrated after 5 minutes. This is in comparison to FIGURE 7, illustrating the hydration performance of the same inventive sample at 70 degrees F, in which 50% hydration occurred at about 60 seconds and 90% hydration occurred after about 5 minutes. Thus, 50% hydration occurred only

30 seconds later in the inventive sample when hydrated at 30 degrees F lower temperature.

In contrast, the prior art sample in FIGURE 6 achieves 50% hydration at 40 degrees F after about 3 minutes, and achieves 90% hydration after about 20 minutes. This is in comparison to FIGURE 5, illustrating the hydration performance of the same prior art sample at 70 degrees F, in which 50% hydration occurred after about 90 seconds, and 90% hydration occurred after about 20 minutes. Therefore, 50% hydration occurred 90 seconds later in the prior art sample when hydrated at 30 degrees F lower temperature.

The foregoing disclosure relates to a process of manufacturing guar gum powder with improved hydration characteristics. As noted above, the polymer of interest in guar gum is polyglactomannan, a polysaccharide. It will be understood that the improved hydration characteristics of guar gum powder are likely to be exhibited by other polymers found in plant seed endosperms, including other polysaccharide-like polymers, when manufactured in powder form according to the inventive process.

It is also known in the art to chemically modify guar gum to achieve other characteristics. For example, it is known to add hydroxypropyl group polymers or carbonymethyl group polymers to the hydrated splits to enhance the achievable final viscosity of the guar gum powder. It will be understood that chemically modified hydrated guar splits are also likely to exhibit improved hydration characteristics when manufactured in powder form according to the inventive process.

It is also known in the art to genetically modify plants so as to achieve desired characteristics. For example, it is known to genetically modify guar gum seeds to alter the plant's climatic requirements so that the crop may be grown in a wider geographic territory. In the case of genetic modification of guar to alter the active polymer provided by the endosperm, it will be understood that powder from the endosperms of such genetically modified guar is also likely to exhibit improved hydration characteristics when manufactured according to the inventive process.

It will be further understood that minimal experimentation would be required by those of skill in this art to identify other plant seed endosperms (whether unmodified, chemically modified or genetically modified) that exhibit improved hydration characteristics when manufactured according to the inventive process. It will be

appreciated that once set up, a manufacturing process built according to the invention can easily process many types of plant seed endosperms with minimal modification, if any. Further, hydration performance of the powder product can be easily measured using well-known testing techniques.

Although the present invention and its advantages have been described in detail, it should be understood that various changes, substitutions and alterations can be made herein without departing from the spirit and scope of the invention as defined by the appended claims.